Nasa CR 65629

AVCO

FINAL REPORT

CONTRACT NAS 9-6158

VAN ALLEN BELT DOSIMETRY SYSTEM

Submitted To

National Aeronautics and Space Administration

Manned Spacecraft Center

Houston, Texas

APRIL 15, 1967

ELECTRONICS DIVISION

TULSA OPERATION

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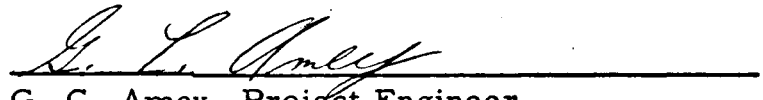
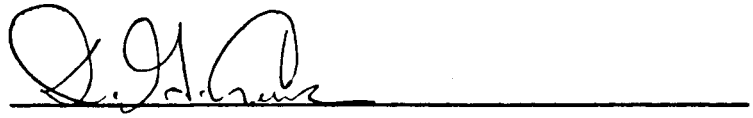
Prepared By: 
G. C. Amey, Project Engineer

Approved By: 
D. G. Crews, Manager of Engineering

Date: April 15, 1967

AVCO ELECTRONICS DIVISION
TULSA OPERATION
TULSA, OKLAHOMA

FOREWORD

This final report for work performed under NASA Contract NAS 9-6158, entitled Van Allen Belt Dosimetry System, is submitted as a Type III document per the terms of the contract. The program was administered under the direction of the Manned Spacecraft Center with Mr. W. Davis, Project Monitor. Mr. G. C. Amey of Avco Electronics Division was Project Engineer.

The basic development of these instruments, sensors, and associated electronics was performed under preceding government contracts, and information regarding theoretical and operational characteristics of the instruments described herein may be obtained from the final reports of Air Force Contracts AF 29(601)-6000, AF 29(601)-6346, and AF 29(601)-6735.

I INTRODUCTION

The tasks of this program have been design modifications, flight package design, fabrication of flight hardware and mock-ups, and testing of the final instruments to ensure satisfactory performance for the Apollo application. Included in the work was the fabrication of six (6) flight-rated, dual sensor instruments, two (2) mechanical mock-ups, and one electronic compatibility test unit. Each instrument contained two independent sensor systems, one for measuring surface dose rate and the other for measuring dose rate at a 5 cm. depth in tissue. Each sensor system was capable of measuring dose rates from 0.001 to 100 rad/hr. All functional and mechanical requirements delineated in the contract were met.

II INSTRUMENT DESCRIPTION

A. Drawing List

A list of drawings and documents used in the construction of the instruments associated with this contract is presented on Avco Drawing and Documentation List, No. 200291. The three drawings classified as interface drawings are: 200358-1 Configuration Outline, 200283-1 Final Assembly, and 200290-1 Material List.

B. Sensors

Each instrument contained two (2) tissue equivalent ionization chamber sensors, each with a range of 0.001 to 100 rad/hr. Both sensors had an inside cavity wall of 1/16" Shonka plastic. In addition to the 1/16" thick Shonka wall, the skin sensor had a 1/16" thick nylon guard enclosing the Shonka, making a total cavity wall thickness of 1/8". The 5 cm. depth sensor had a Delrin wall enclosing the Shonka wall, such that the total wall thickness was 5 cm. thick for the uninterrupted solid angle of the sensor (see Drawing 200283-1). Internal pressure of the depth and skin sensors was 20 atmosphere and 1 atmosphere, respectively. Volumes of the depth and skin ion chamber cavities were 5.2 cm^3 and 197 cm^3, respectively. Both

sensors had a collecting electrode fabricated from Shonka plastic and a collection potential of 100 volts. Electrometer tube preamps were used with the sensors to amplify the ion current and provide a logarithmic transfer function. The high voltage electrode or cavity walls were put at ground potential and the collecting electrode and preamp floated at the negative high voltage potential.

C. Signal Conditioning

Conditioning of the signal from the preamp-sensor assembly was accomplished using a full-wave, push-pull magnetic amplifier. The amplifier converted the electrometer plate current to a 0-5 VDC telemetry-compatible output. Short circuit protection and hard output limiting was incorporated in the amplifier.

D. Power Supply

A switching regulator and a saturable transformer DC to DC converter was used to provide the necessary sensor and electronics power. The input power circuit incorporated a 0.5 amp fuse and reverse polarity protection. Regulated outputs from the supply included 40 volts A.C., +10 VDC, -100 VDC, and -3.5 VDC, +6.5 VDC and +1.6 VDC referenced to the -100 VDC potential.

III SUMMARY OF RESULTS

A. Test and Calibration Results

A summary of the acceptance test results for the six instruments is presented in Table 1. The calibration curves for the instruments are illustrated in Figures 1 - 24. A complete set of in-process and acceptance test data is contained in the Log Book accompanying each instrument.

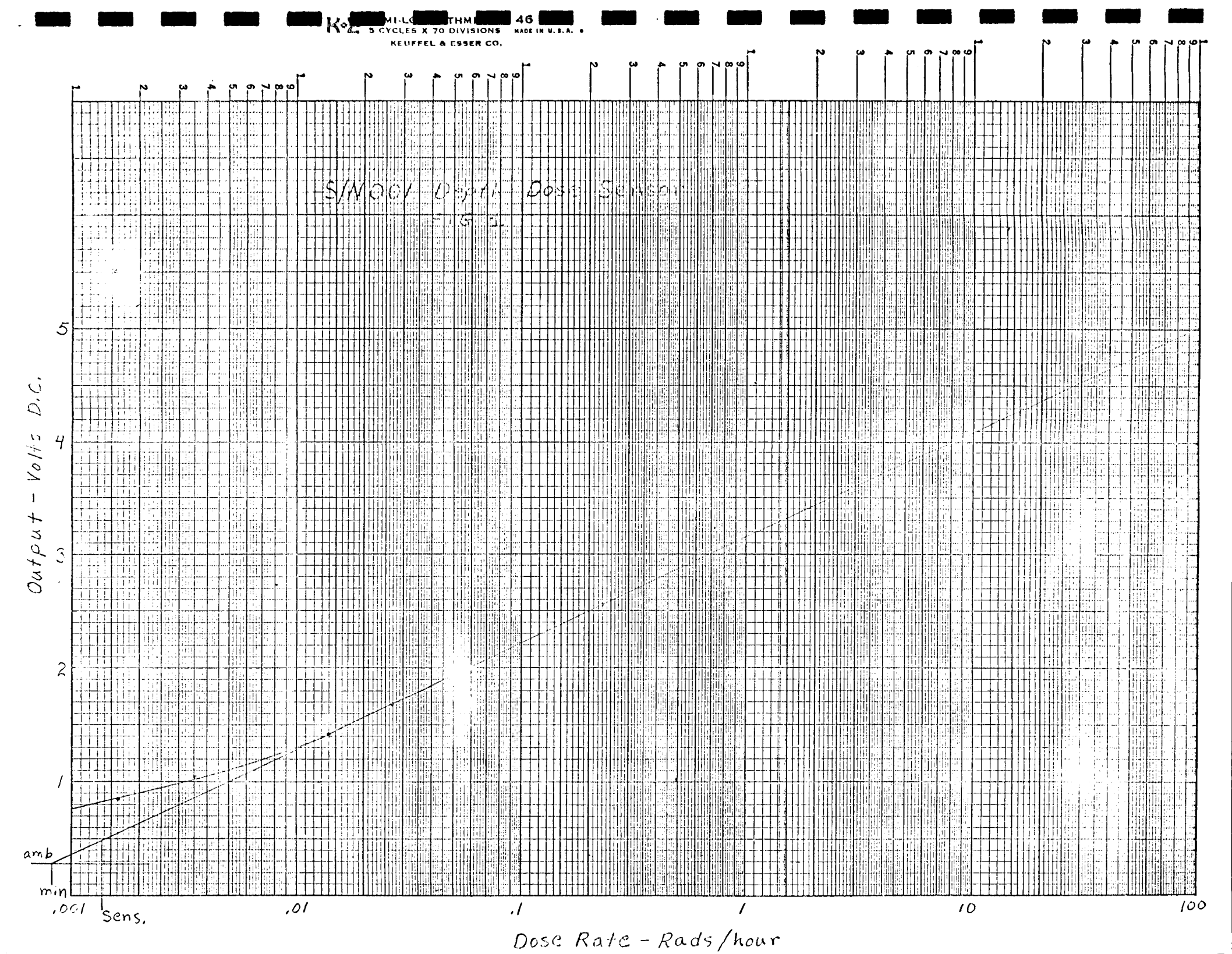
IV RECOMMENDATIONS AND CONCLUSIONS

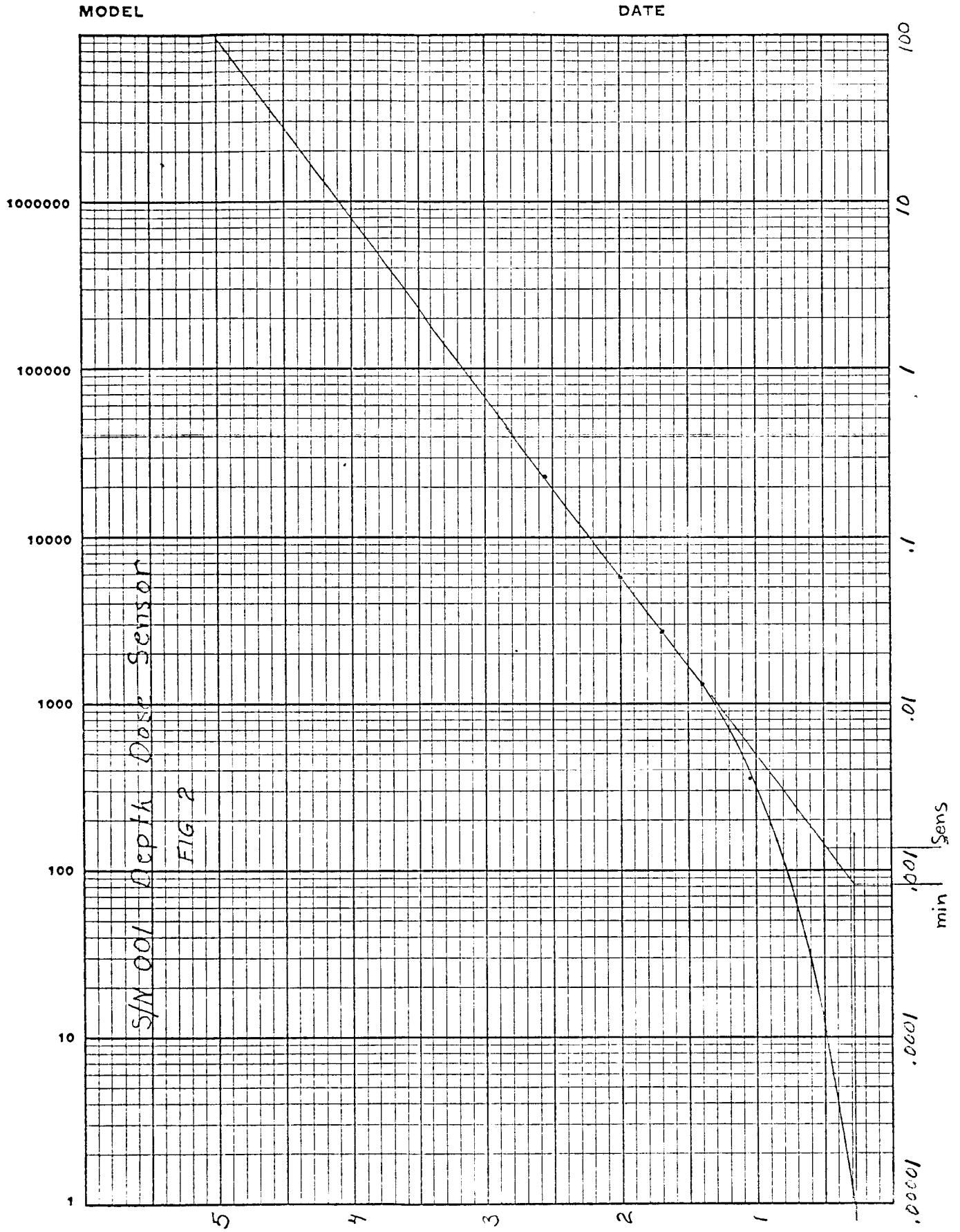
The only recommendation that Avco has is that a more suitable mounting interface be established between the instrument and the vehicle structure. The configuration of the instrument being long and narrow, with the center of gravity approximately in the center, makes it susceptible to vibration resonances if not properly mounted.

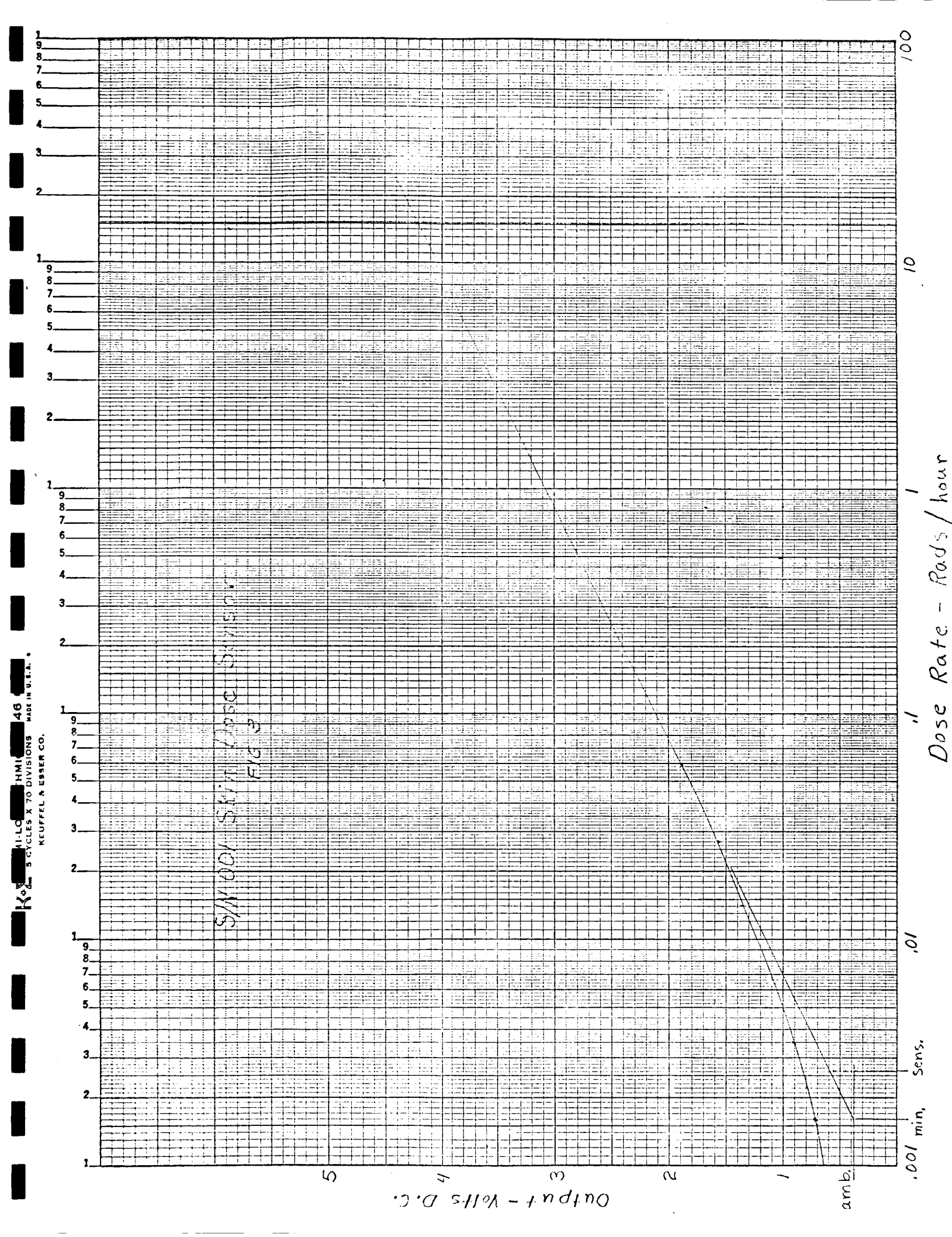
Avco concludes that the instruments designed and fabricated on this program will do the job they are intended for. It is felt that the information obtained from these instruments on the radiation environment inside a manned space vehicle will make a significant contribution toward man's understanding of the hazards of space travel.

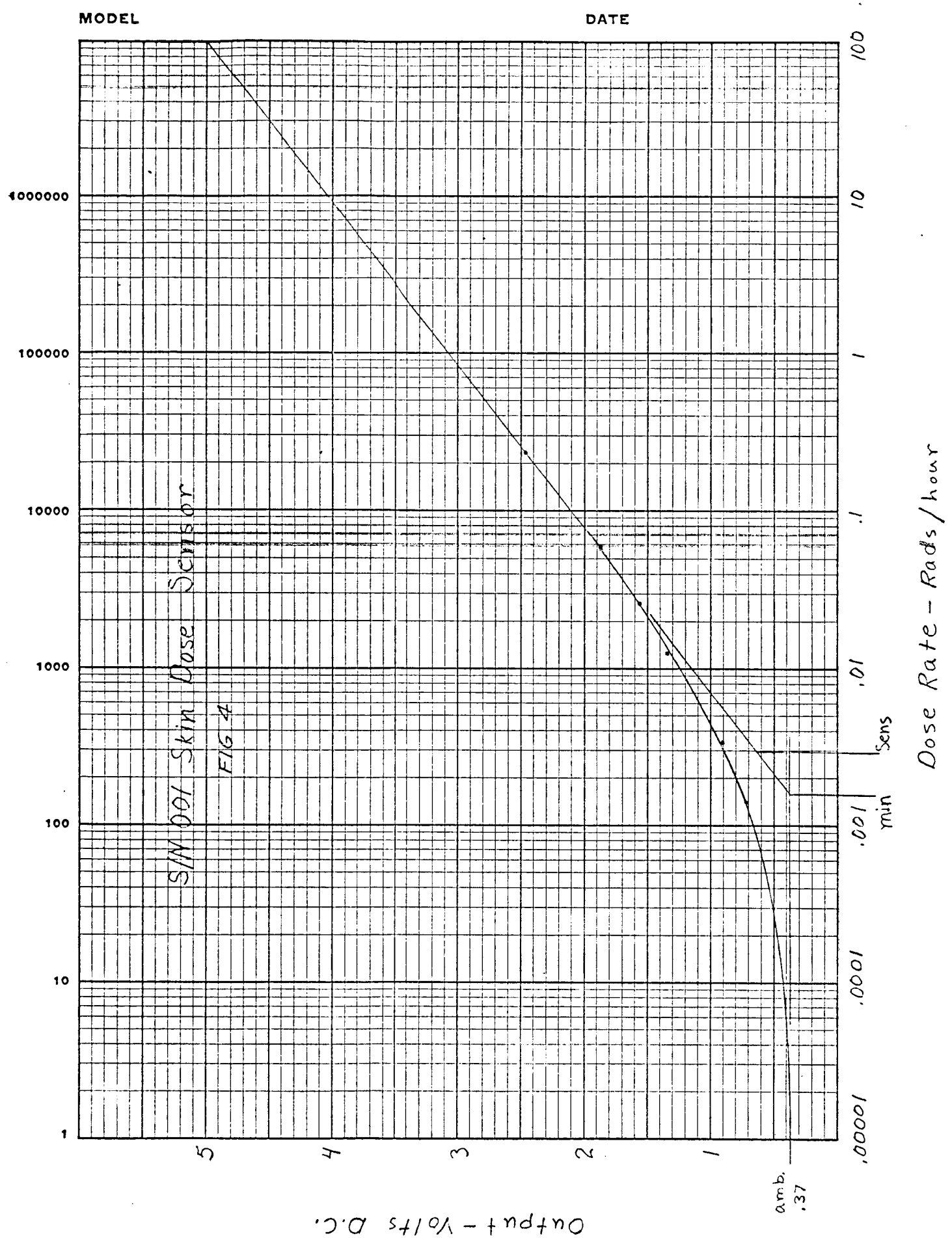
TABLE I

Ref. Paragraph End Item Test Procedure No. 200370	500 MW Max. 4.3 b, c, d			1.5% Max. 4.3 f		.004 RAD/Hr. Maximum 4.4 i (1)		.002 RAD/Hr. Maximum 4.4 i (2)		100 ±10 RAD/Hr. 4.4 i (2)		T_R or T_F = 2 Sec. Max. 4.5			
S/N	Input Power (MW) at Input Voltage of			Regulation (%)		Sensitivity (RAD/Hr.)		Minimum (RAD/Hr.)		Maximum (RAD/Hr.)		Response Time (Sec.) T_R		T_F	
	24	28	32	5 cm.	Skin	5 cm.	Skin	5 cm.	Skin	5 cm.	Skin	5 cm.	Skin	5 cm.	Skin
1	312	350	384	0.00	0.36	0.0014	0.0026	0.0008	0.0016	95	100	1.02	0.60	1.35	0.84
2	324	348	374	0.38	0.37	0.0023	0.0018	0.0014	0.0011	100	96	0.96	0.50	1.25	0.86
3	319	347	371	0.36	0.37	0.0015	0.0020	0.0009	0.0012	95	100	0.84	0.47	1.15	0.78
4	335	358	390	0.36	0.36	0.0017	0.0016	0.0010	0.0010	100	96	0.96	0.51	1.32	0.90
7	331	364	400	0.00	0.20	0.0023	0.0040	0.0014	0.0019	100	100	1.35	0.72	1.80	0.93
8	336	359	400	0.00	0.20	0.0016	0.0022	0.0010	0.0013	100	98	0.69	0.54	1.08	0.84

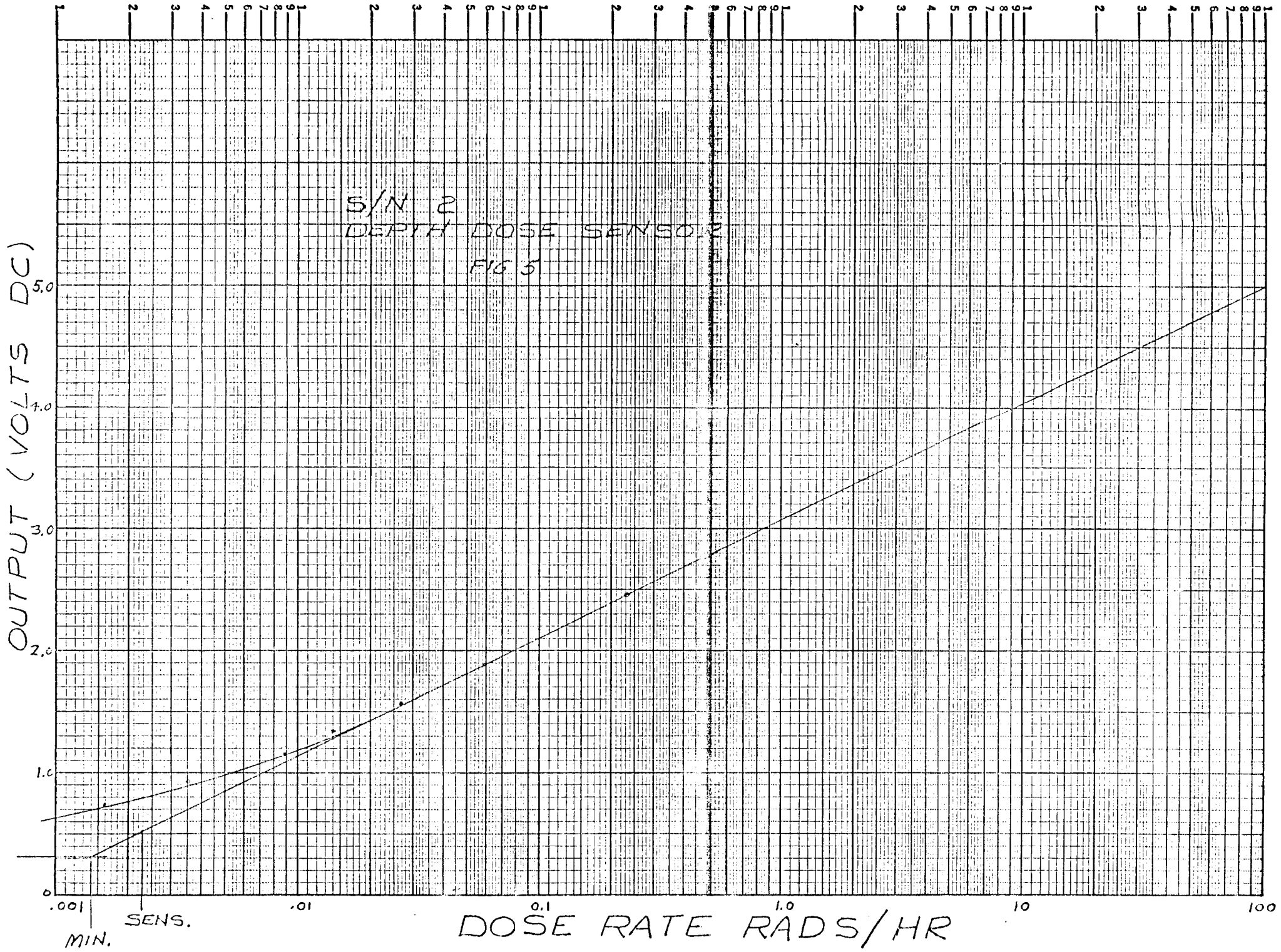

KEUFFEL & ESSER CO.
5 CYCLES X 70 DIVISIONS
MADE IN U.S.A.
Output - Volts D.C.
5
4
3
2
1
amb
min
.001
Sens.
.01
.1
1
10
100
Dose Rate - Rads/hour

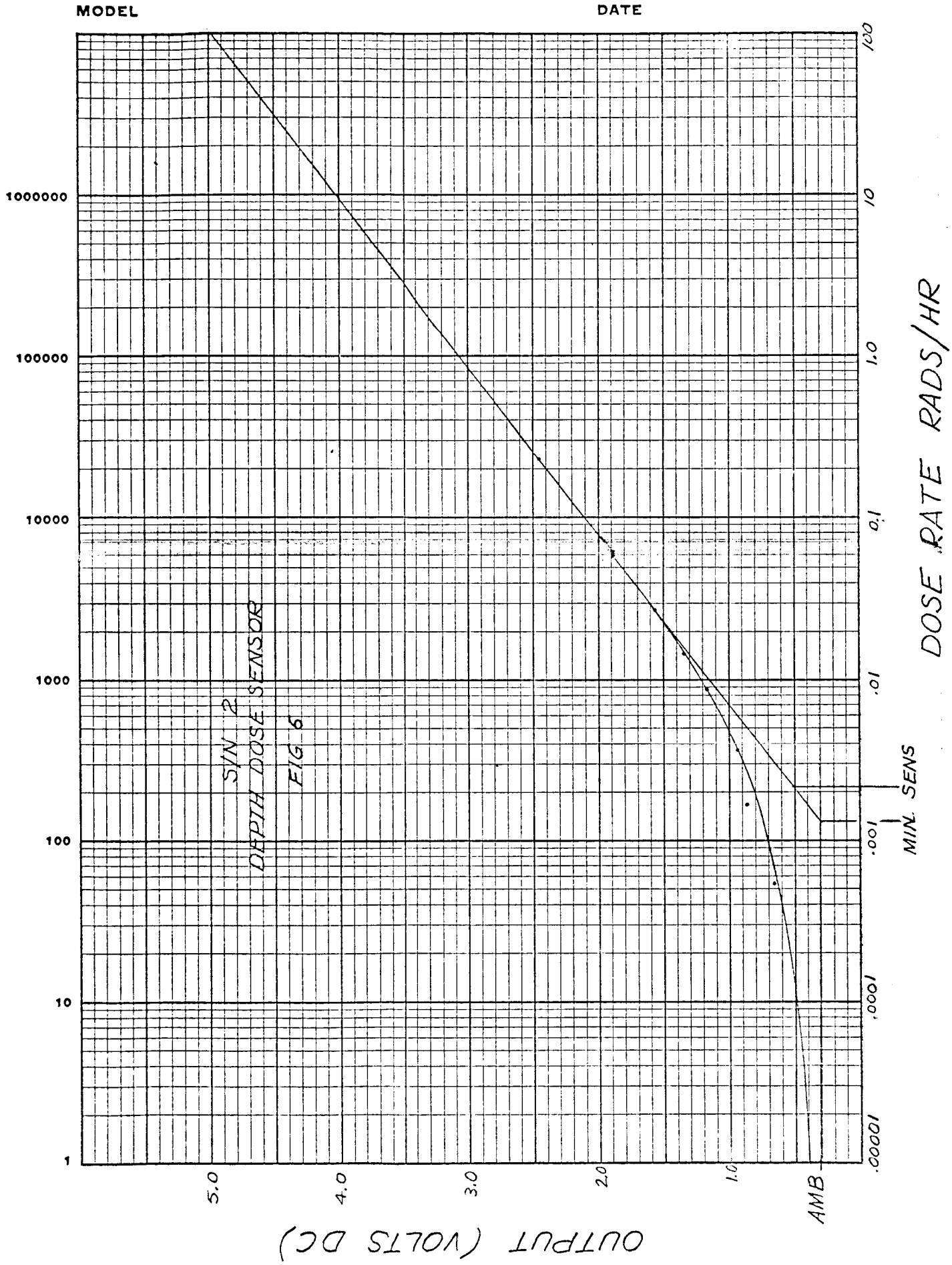

MODEL
DATE
1000000
100000
10000
1000
100
10
1
100
10
1
.1
.01
.001
.0001
.00001
5
4
3
2
1
min
Sens
S/N 001 Depth Dose Sensor
FIG 2
Output - Volts D.C.
Dose Rate - Rads/hour
KEUFFEL & ESSER CO.
7 CYCLES X 60 DIVISIONS
MADE IN U.S.A.


Output - Volts D.C.
Dose Rate - Rads / hour
5
4
3
2
1
amb.
100
10
1
.1
.01
.001 min. Sens.
SW 00 SERIES DOSIMETER
KEUFFEL & ESSER CO.
MADE IN U.S.A.

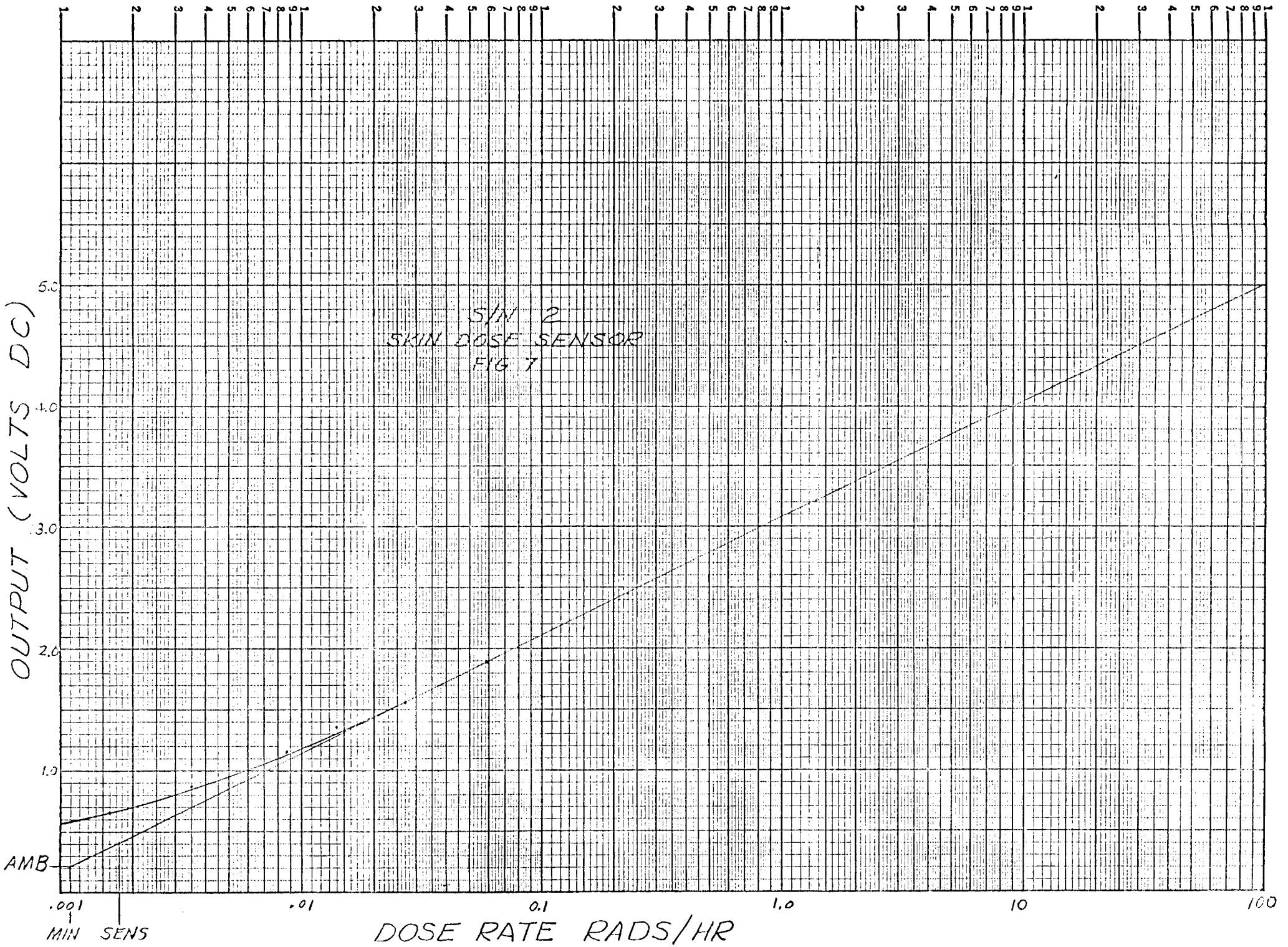


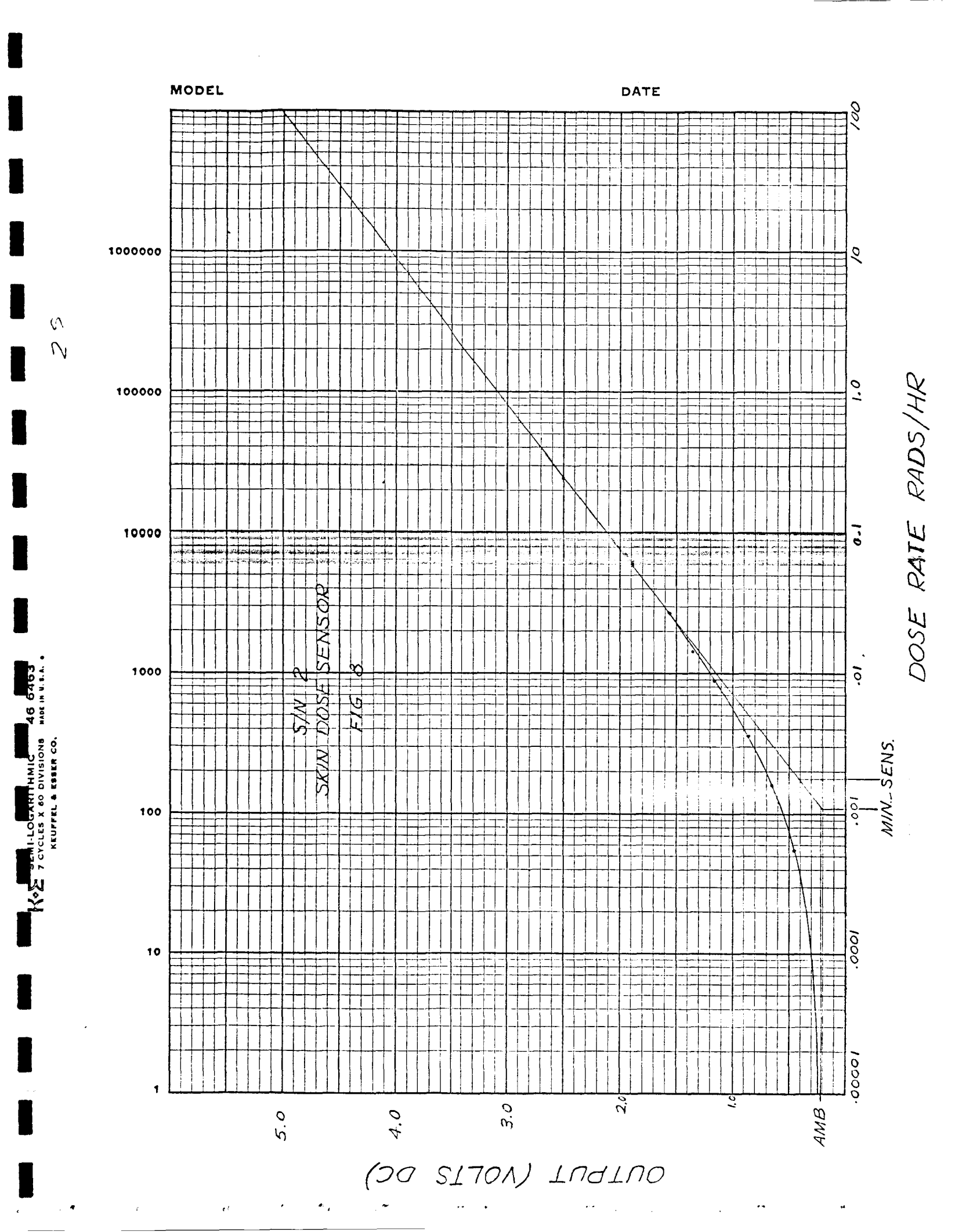
KEUFFEL & ESSER CO. MADE IN U.S.A.
5 CYCLES X 70 DIVISIONS

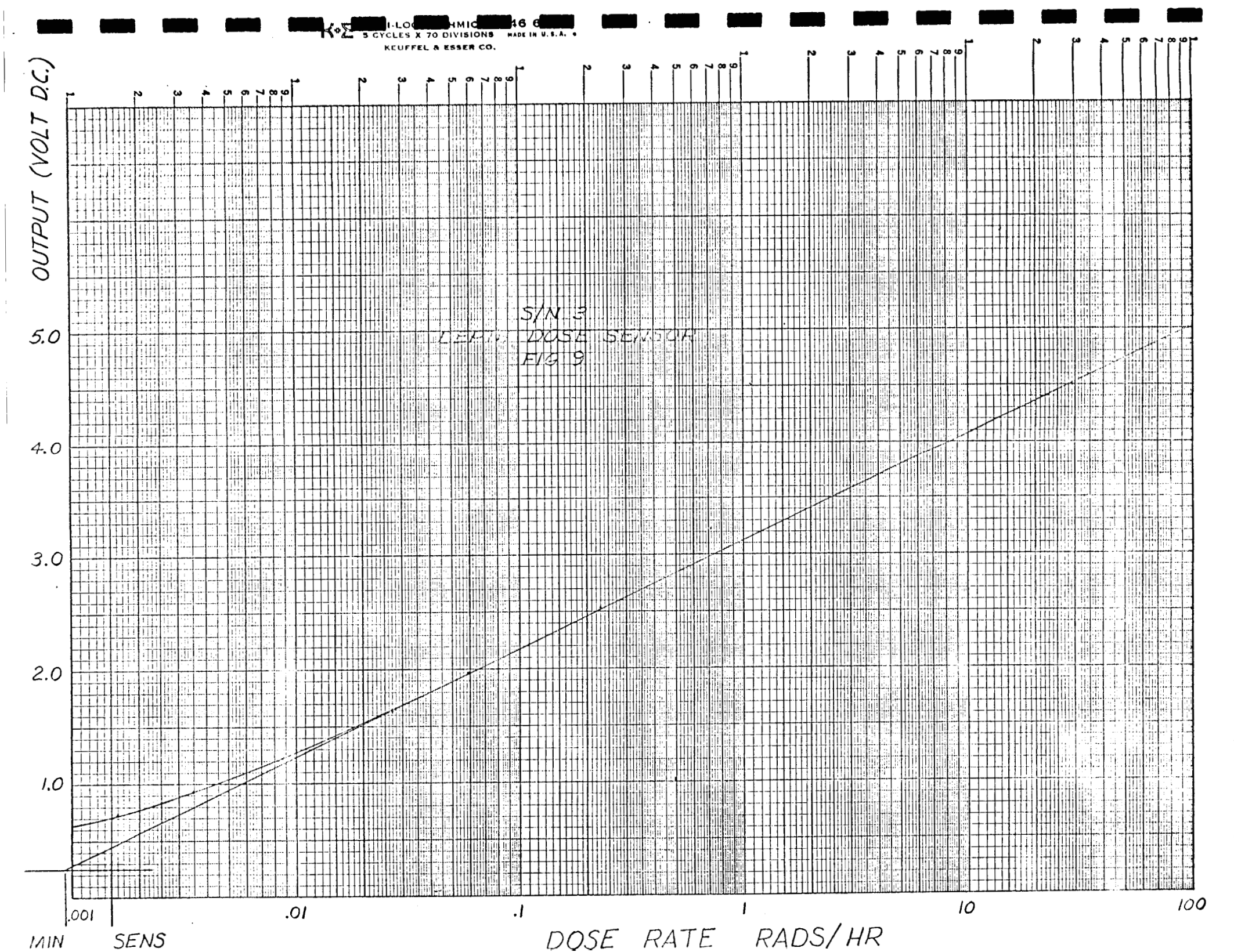


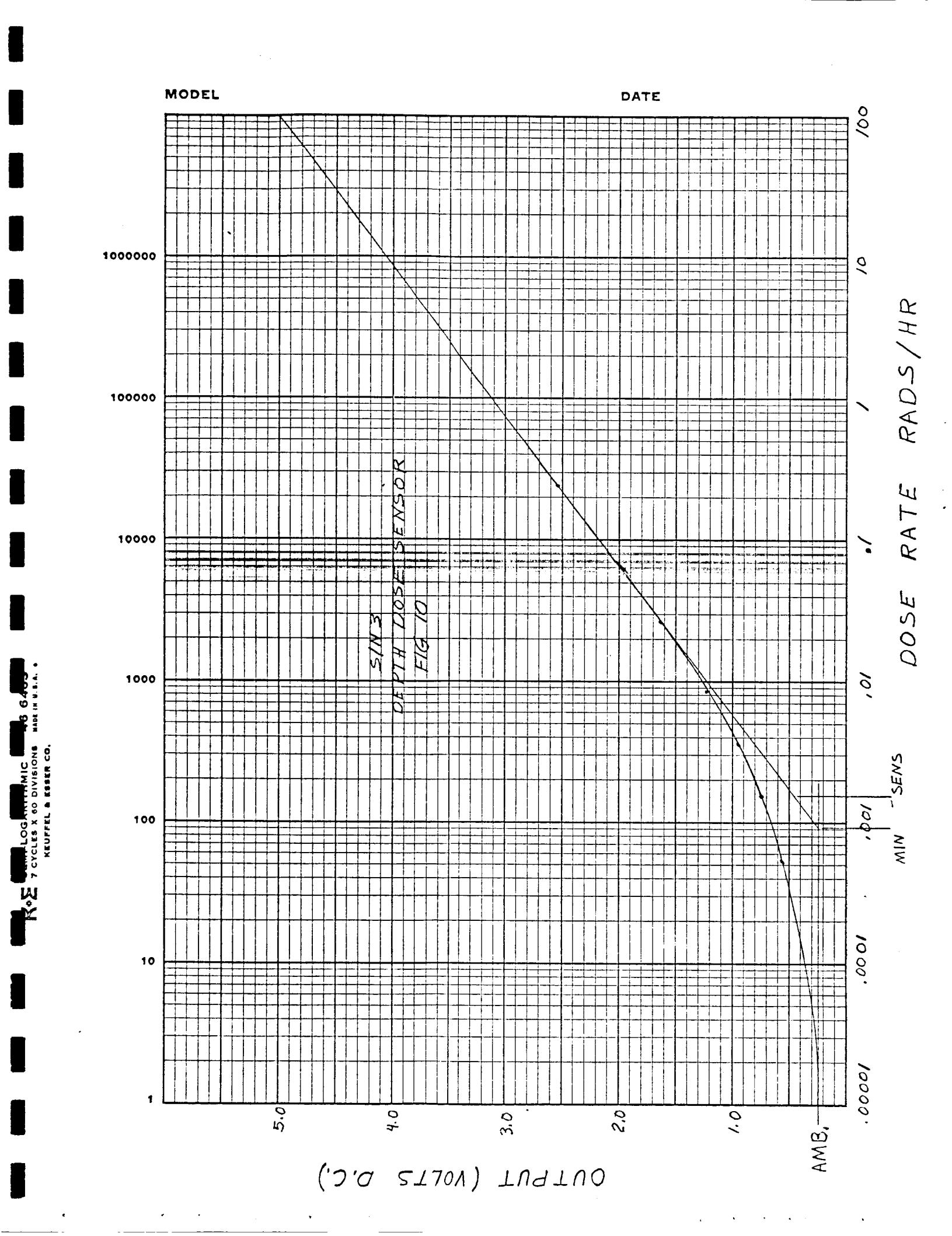

MODEL
DATE
1000000
100000
10000
1000
100
10
1
100
10
1.0
0.1
.01
.001
.0001
.00001
MIN. SENS
AMB
5.0
4.0
3.0
2.0
1.0
OUTPUT (VOLTS DC)
DOSE RATE RADS/HR
S/N 2
DEPTH DOSE SENSOR
FIG 6
2D
KE
7 CYCLES X 60 DIVISIONS
KEUFFEL & ESSER CO.

KEUFFEL & ESSER CO. MADE IN U.S.A.
5 CYCLES X 70 DIVISIONS

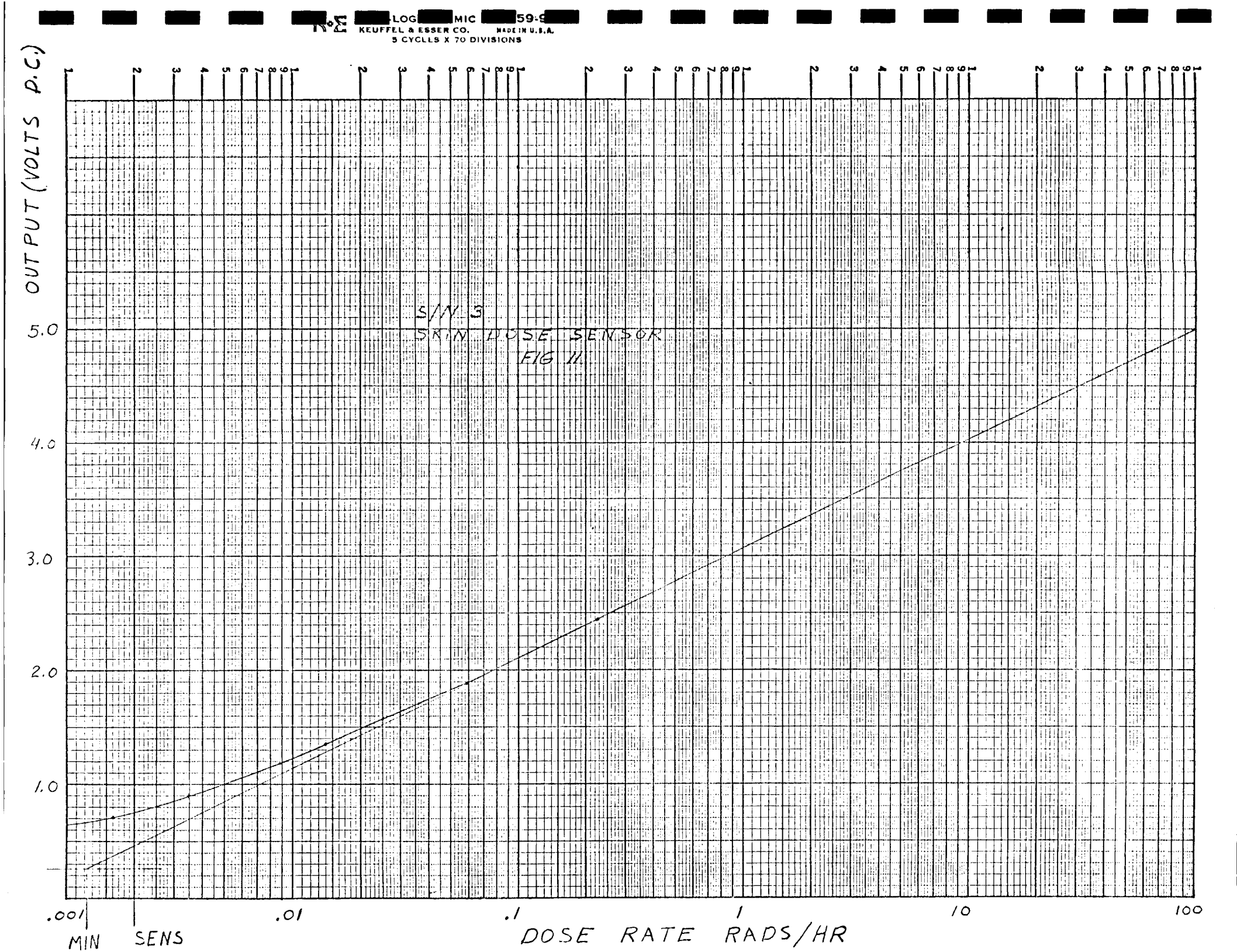


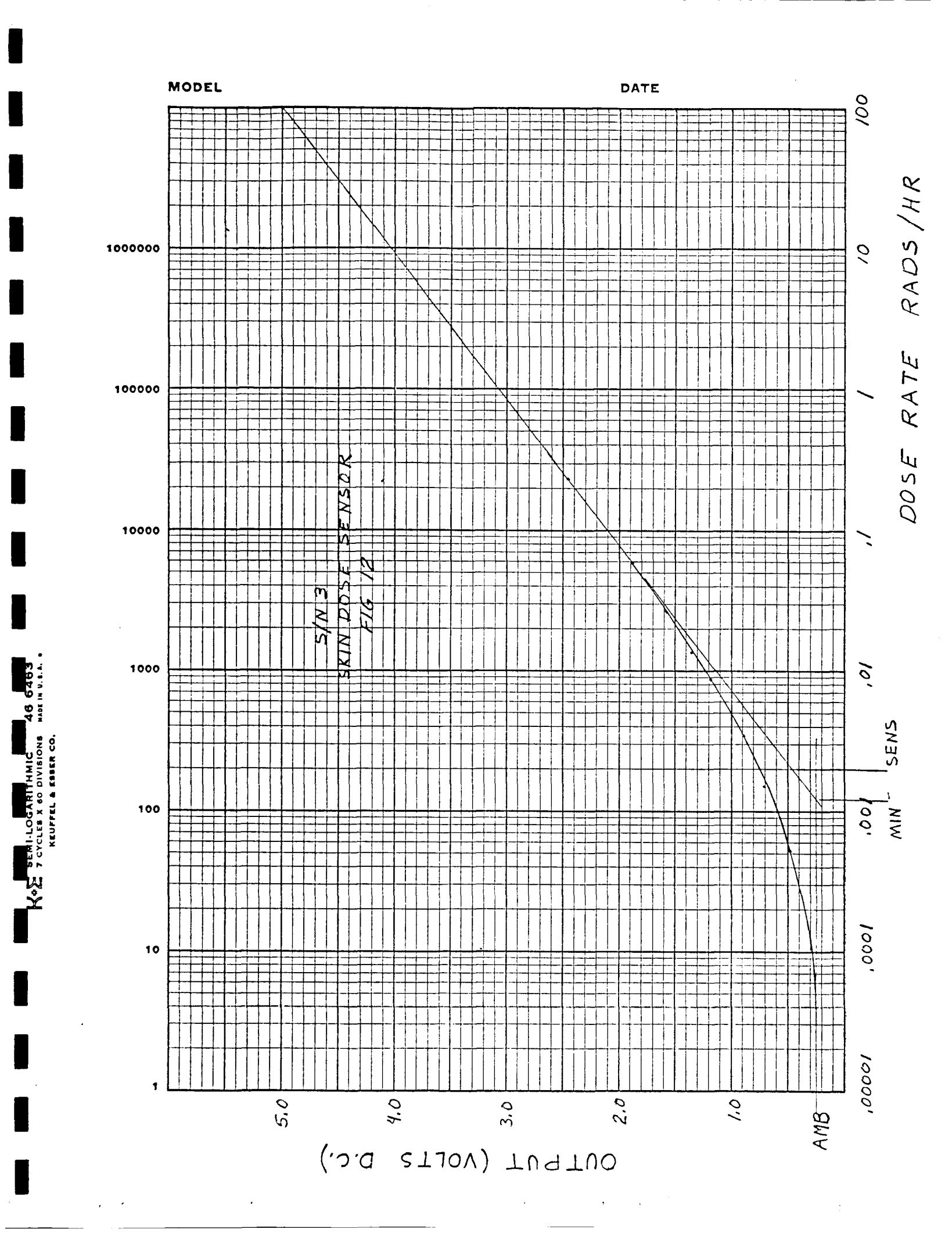

MODEL
DATE
1000000
100000
10000
1000
100
10
1
100
10
1.0
0.1
.01
.001
.0001
.00001
5.0
4.0
3.0
2.0
1.0
AMB
S/N 2
SKIN DOSE SENSOR
FIG 8
MIN. SENS.
DOSE RATE RADS/HR
OUTPUT (VOLTS DC)
SEMI-LOGARITHMIC
7 CYCLES X 60 DIVISIONS
KEUFFEL & ESSER CO.
MADE IN U.S.A.
46 6453

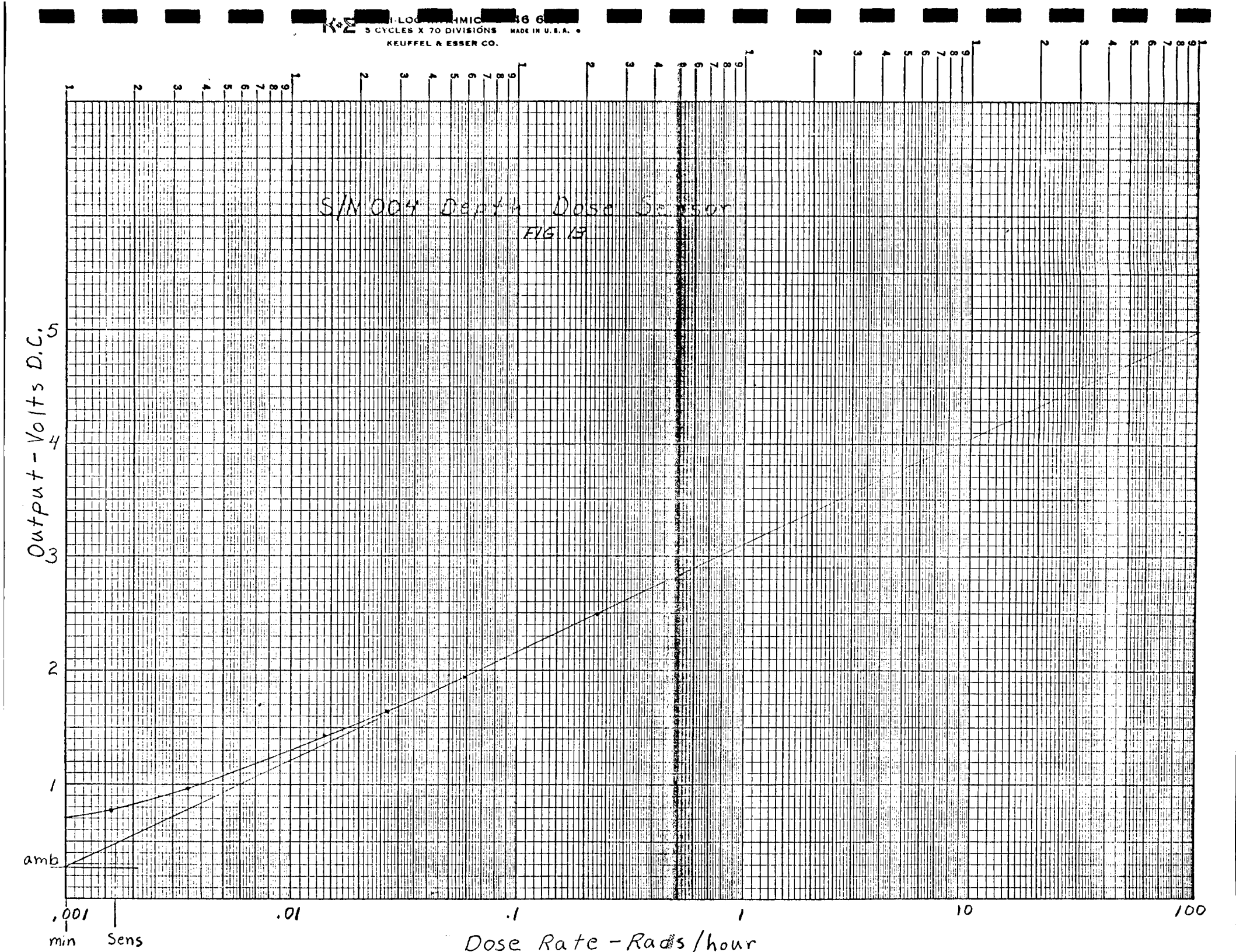

5 CYCLES X 70 DIVISIONS
MADE IN U.S.A.
KEUFFEL & ESSER CO.
OUTPUT (VOLT DC.)
5.0
4.0
3.0
2.0
1.0
S/N 3
DEPT. DOSE SENSOR
FIG 9
.001
.01
.1
1
10
100
MIN SENS
DOSE RATE RADS/HR

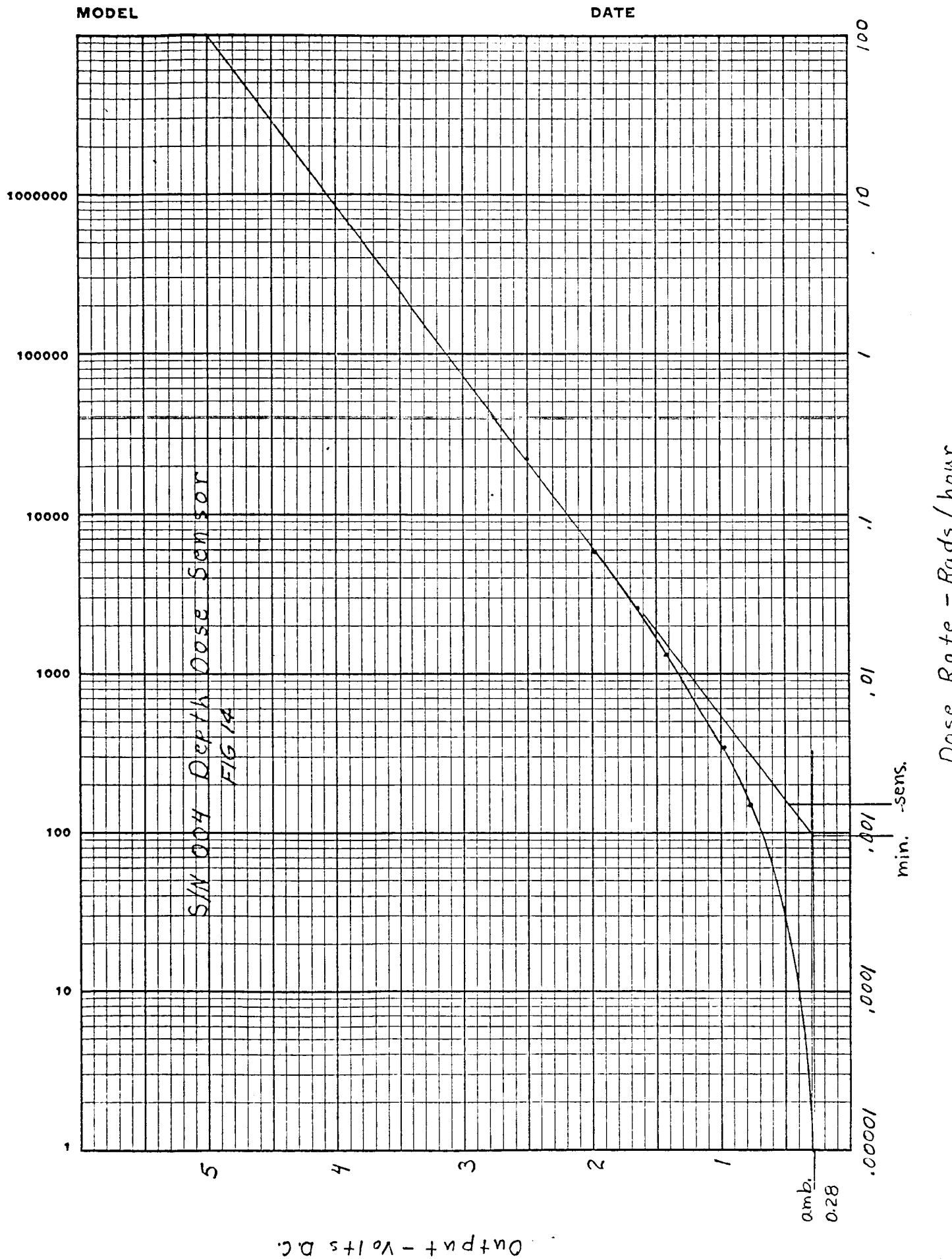

MODEL
DATE
1000000
100000
10000
1000
100
10
1
100
10
1
.1
.01
.001
.0001
.00001
SIN 3
DEPTH DOSE SENSOR
FIG 10
DOSE RATE RADS/HR
MIN SENS
AMB.
5.0
4.0
3.0
2.0
1.0
OUTPUT (VOLTS D.C.)
LOGARITHMIC
7 CYCLES X 60 DIVISIONS
KEUFFEL & ESSER CO.

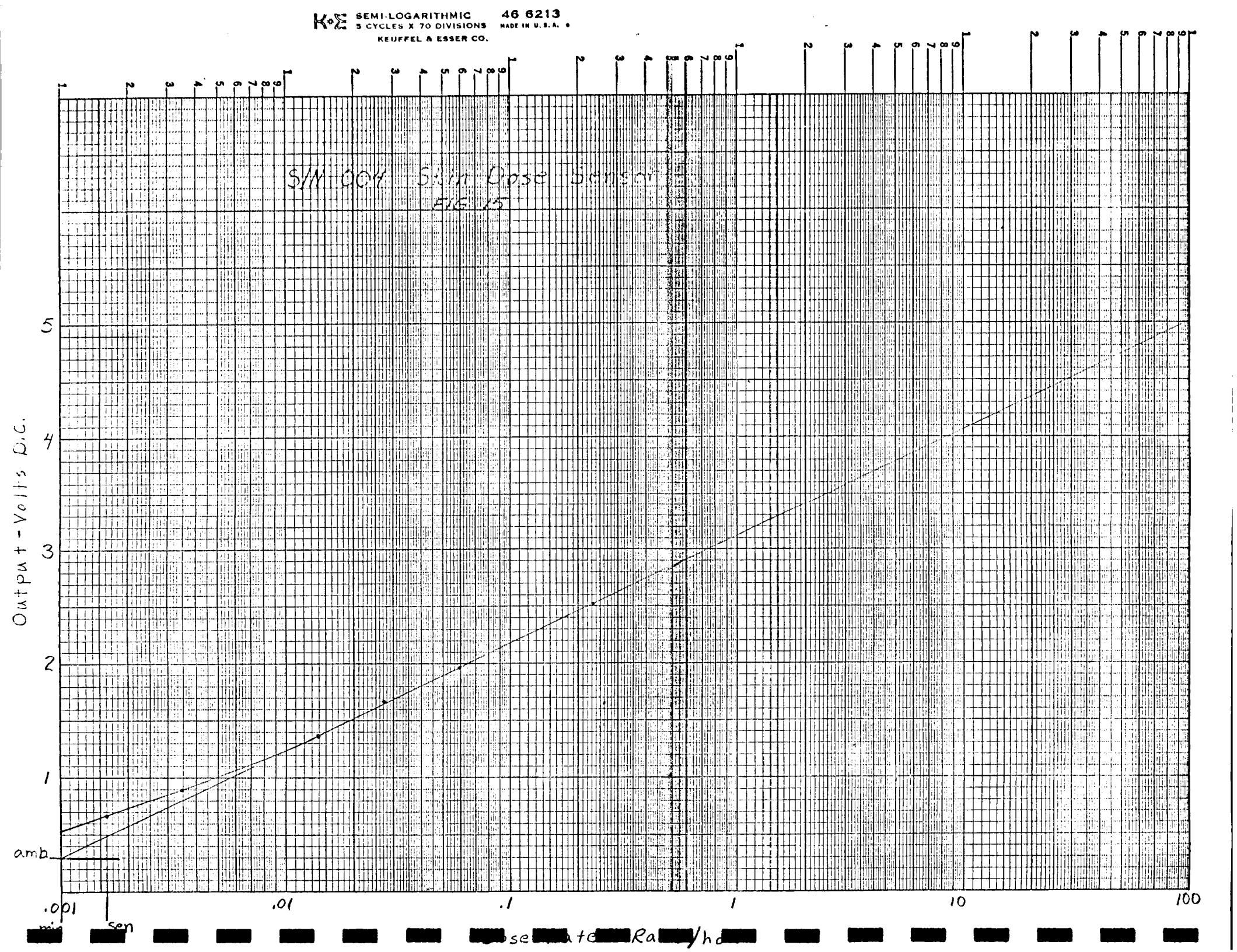
[redacted] LOG [redacted] MIC [redacted] 59-9
KEUFFEL & ESSER CO. MADE IN U.S.A.
5 CYCLES X 70 DIVISIONS

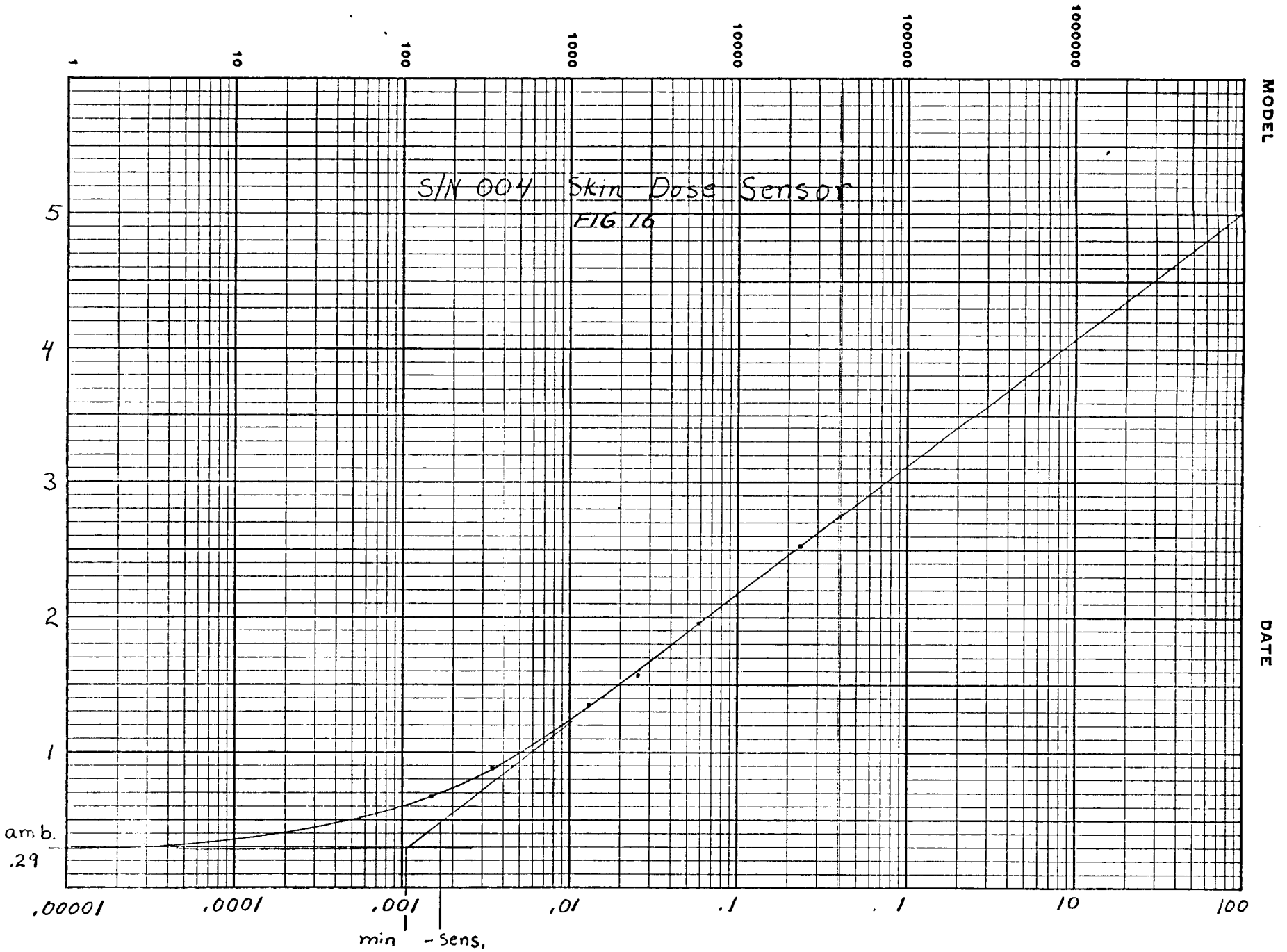


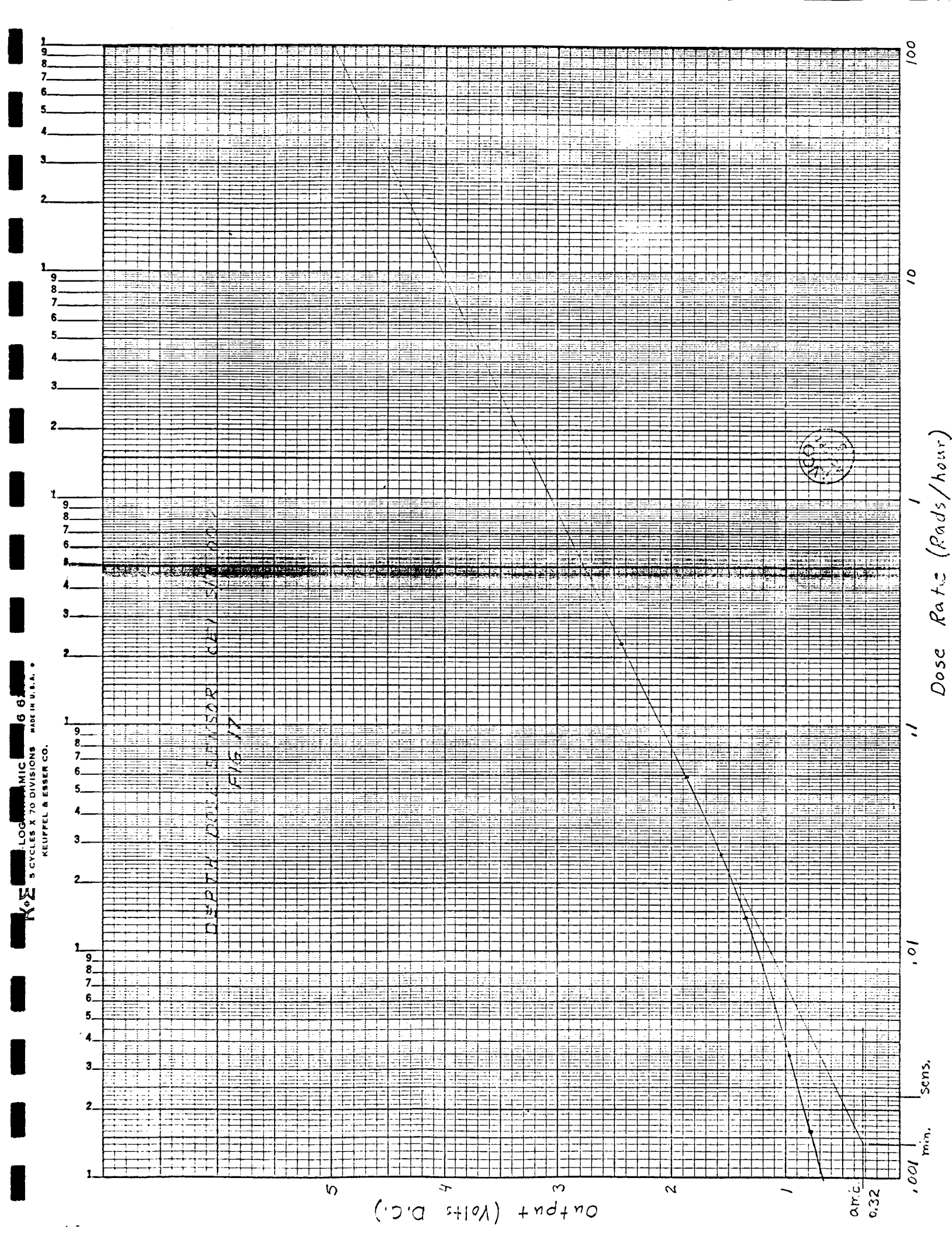

MODEL
DATE
1000000
100000
10000
1000
100
10
1
S/N 3
SKIN DOSE SENSOR
FIG 12
100
10
1
.1
.01
.001
.0001
.00001
DOSE RATE RADS/HR
MIN SENS
5.0
4.0
3.0
2.0
1.0
AMB
OUTPUT (VOLTS D.C.)
SEMI-LOGARITHMIC
7 CYCLES X 60 DIVISIONS
KEUFFEL & ESSER CO.
MADE IN U.S.A.
46 6463

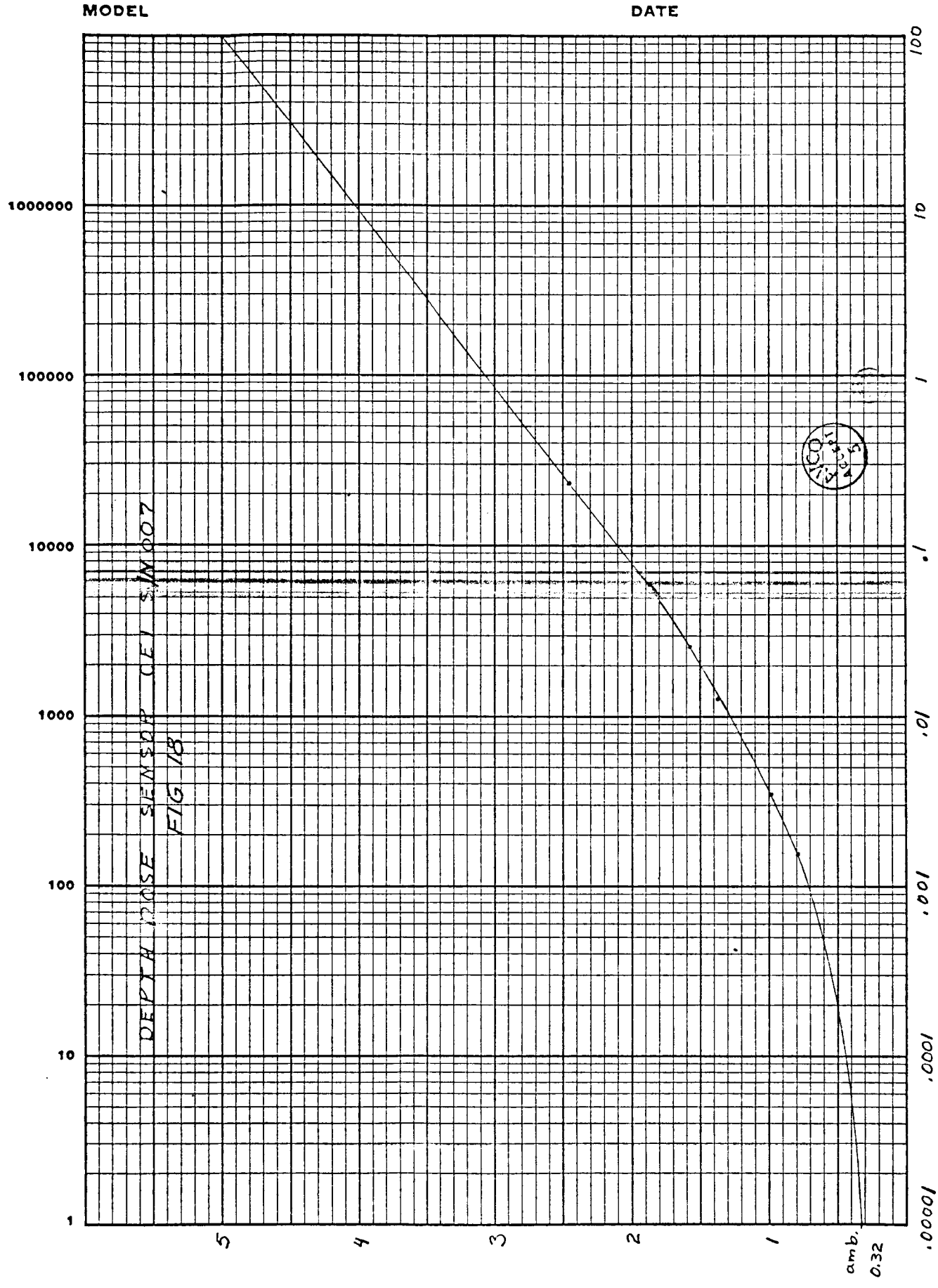

KEUFFEL & ESSER CO.
5 CYCLES X 70 DIVISIONS
MADE IN U.S.A.
SIM 004 Depth Dose Dosimeter
FIG 13
Output - Volts D.C.
5
4
3
2
1
amb
.001
min
Sens
.01
.1
1
10
100
Dose Rate - Rads/hour


MODEL
DATE
1000000
100000
10000
1000
100
10
1
5
4
3
2
1
amb.
0.28
100
10
1
.1
.01
.001
.0001
.00001
min. sens.
S/N 004 Depth Dose Sensor
FIG 12
Output - Volts D.C.
Dose Rate - Rads/hour
SEMILOGARITHMIC
7 CYCLES X 90 DIVISIONS
KEUFFEL & ESSER CO.
MADE IN U.S.A.

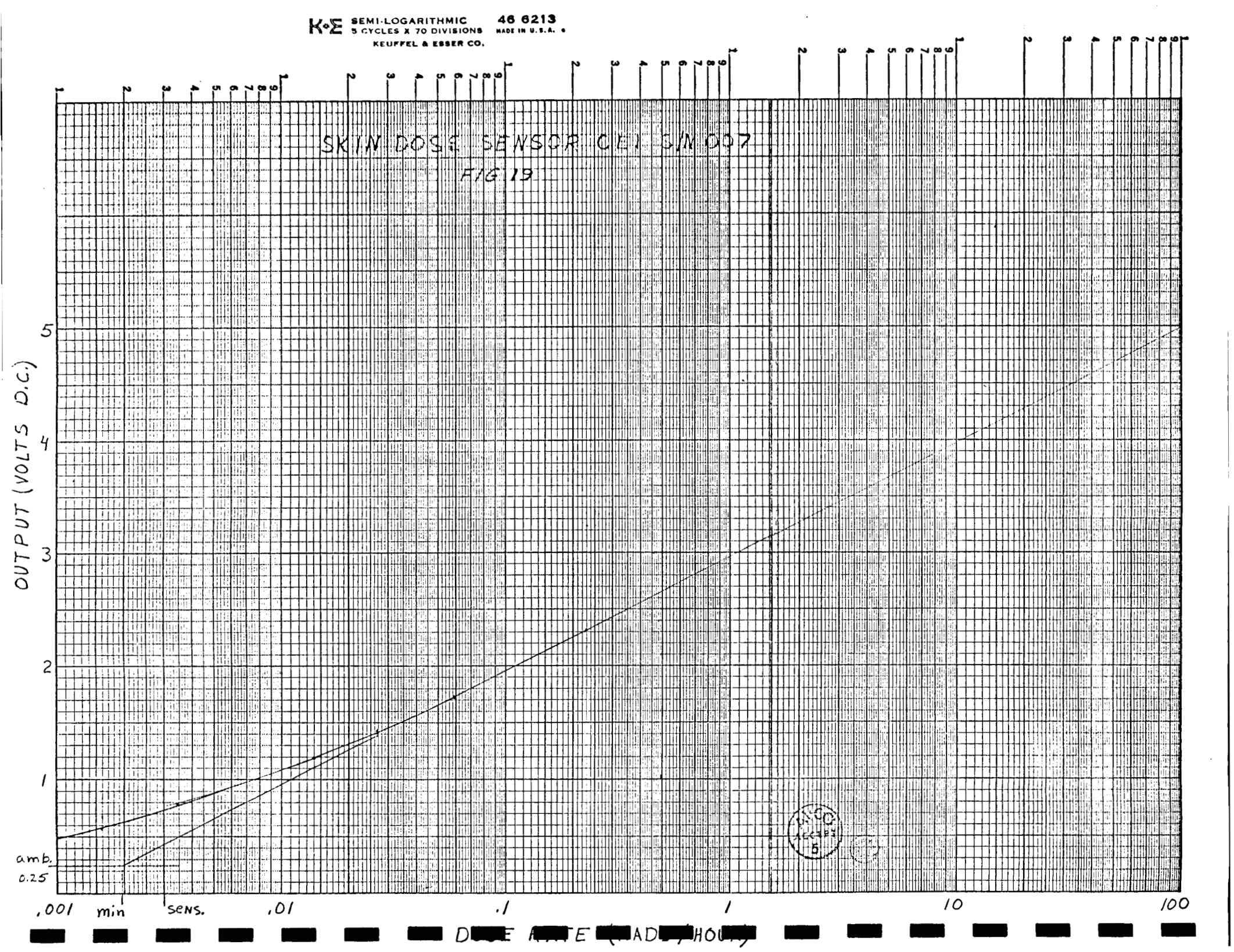

K&E SEMI-LOGARITHMIC 46 6213
5 CYCLES X 70 DIVISIONS MADE IN U.S.A.
KEUFFEL & ESSER CO.
S/M 004 Survey Dose Sensor
Fig 15
Output - Volts D.C.
5
4
3
2
1
amb
.001
.01
.1
1
10
100
min
sen
Dose Rate Ra /hr

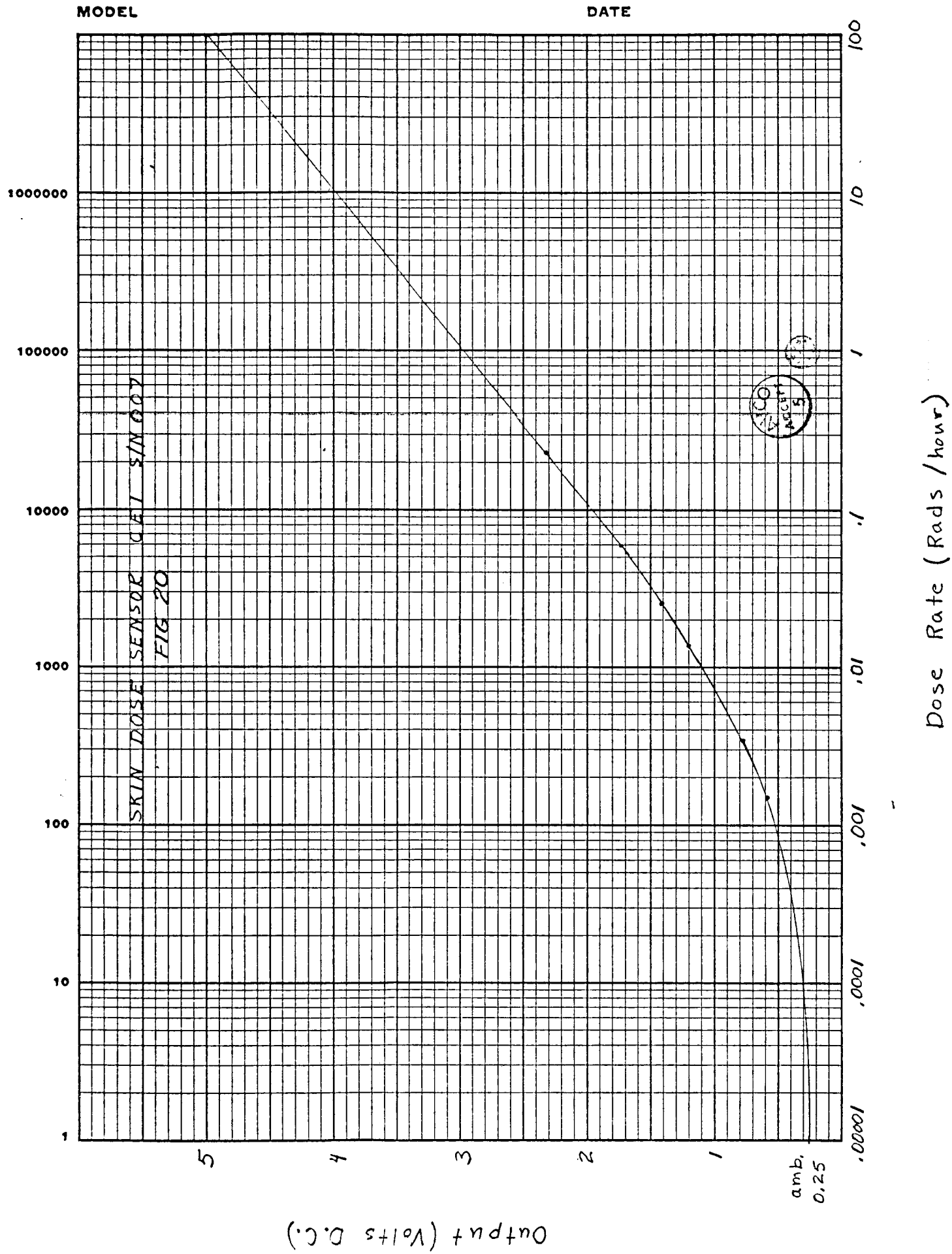


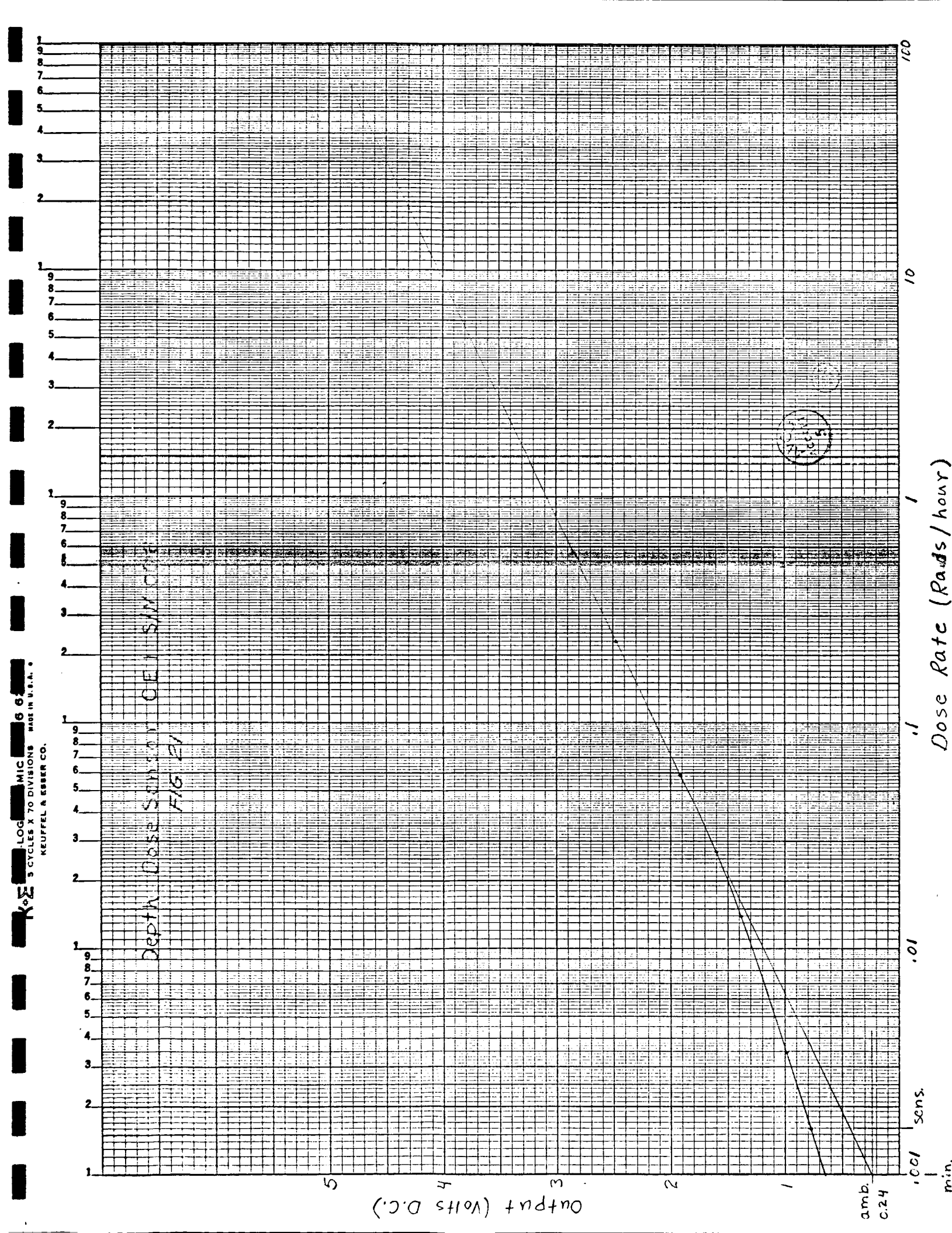

Dose Rate (Rads/hour)
Output (Volts D.C.)
sens.
min.
amic.
0.32
KEUFFEL & ESSER CO.
MADE IN U.S.A.

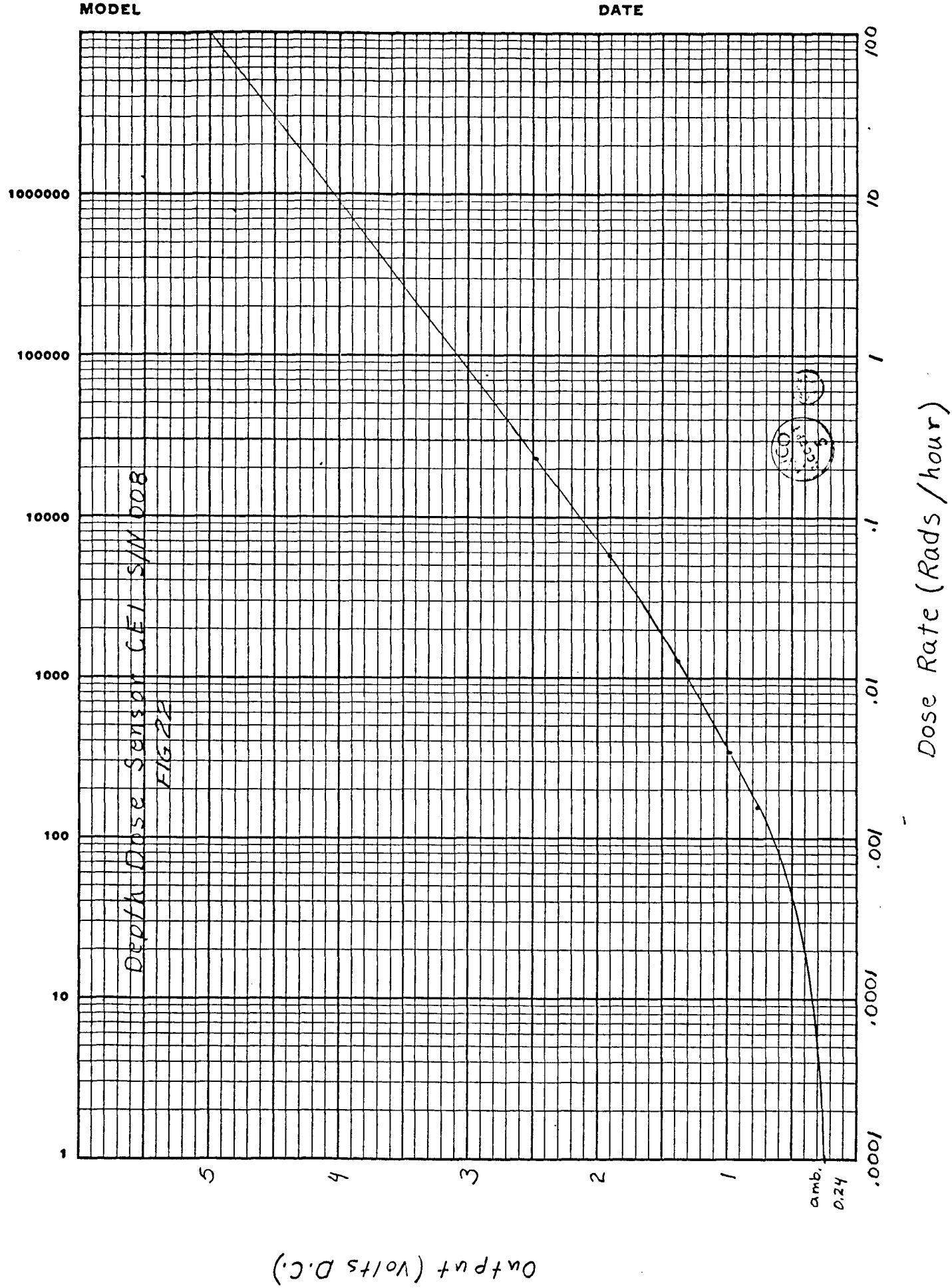

MODEL
DATE
1000000
100000
10000
1000
100
10
1
100
10
1
.1
.01
.001
.0001
.00001
5
4
3
2
1
amb.
0.32
output (Volts D.C.)
Dose Rate (Rads / hour)
DEPTH DOSE SENSOR CEI SN 007
FIG 18
VICO
K+E
7 CYCLES X 60 DIVISIONS
KEUFFEL & ESSER CO.

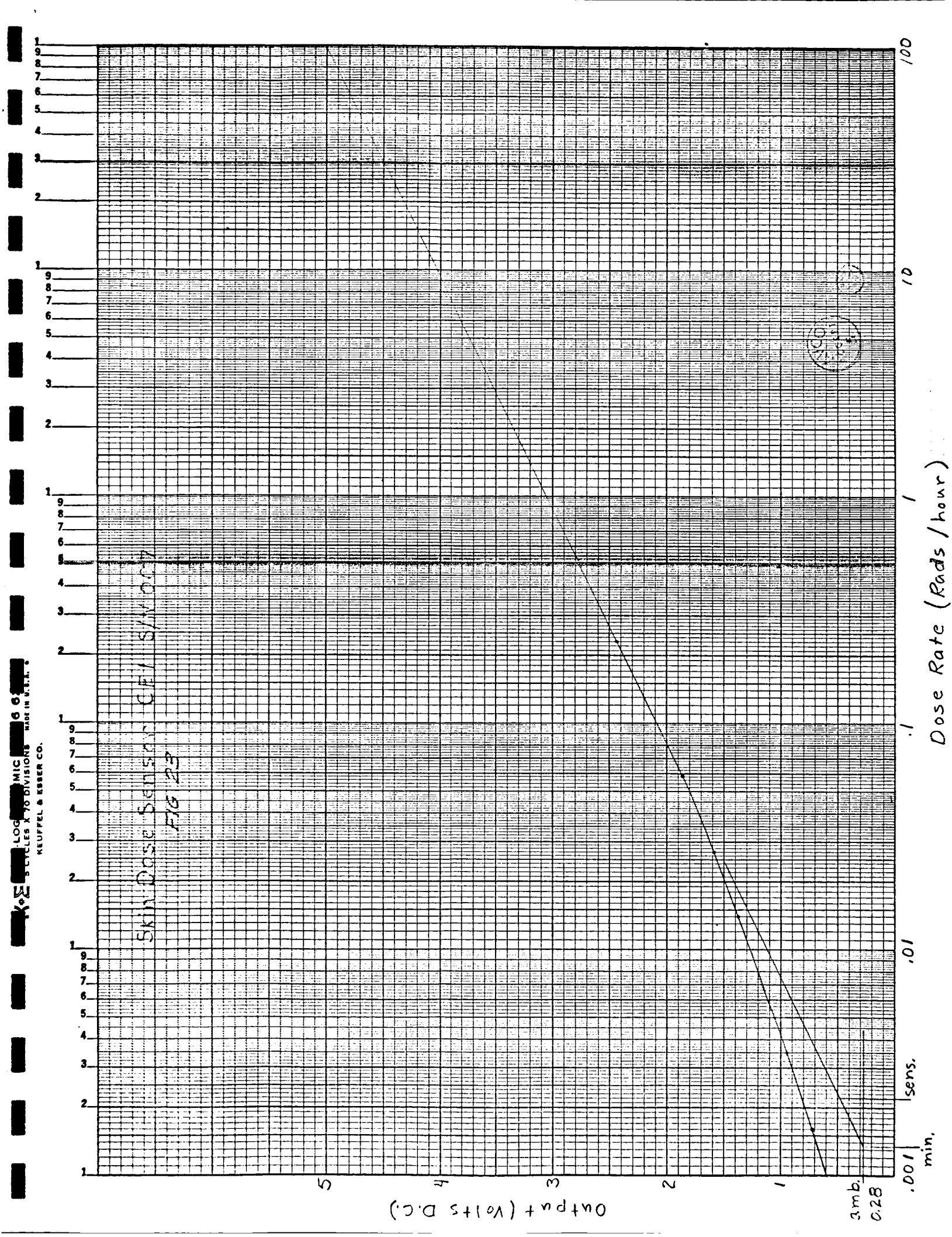
K&E SEMI-LOGARITHMIC 46 6213
5 CYCLES X 70 DIVISIONS MADE IN U.S.A.
KEUFFEL & ESSER CO.

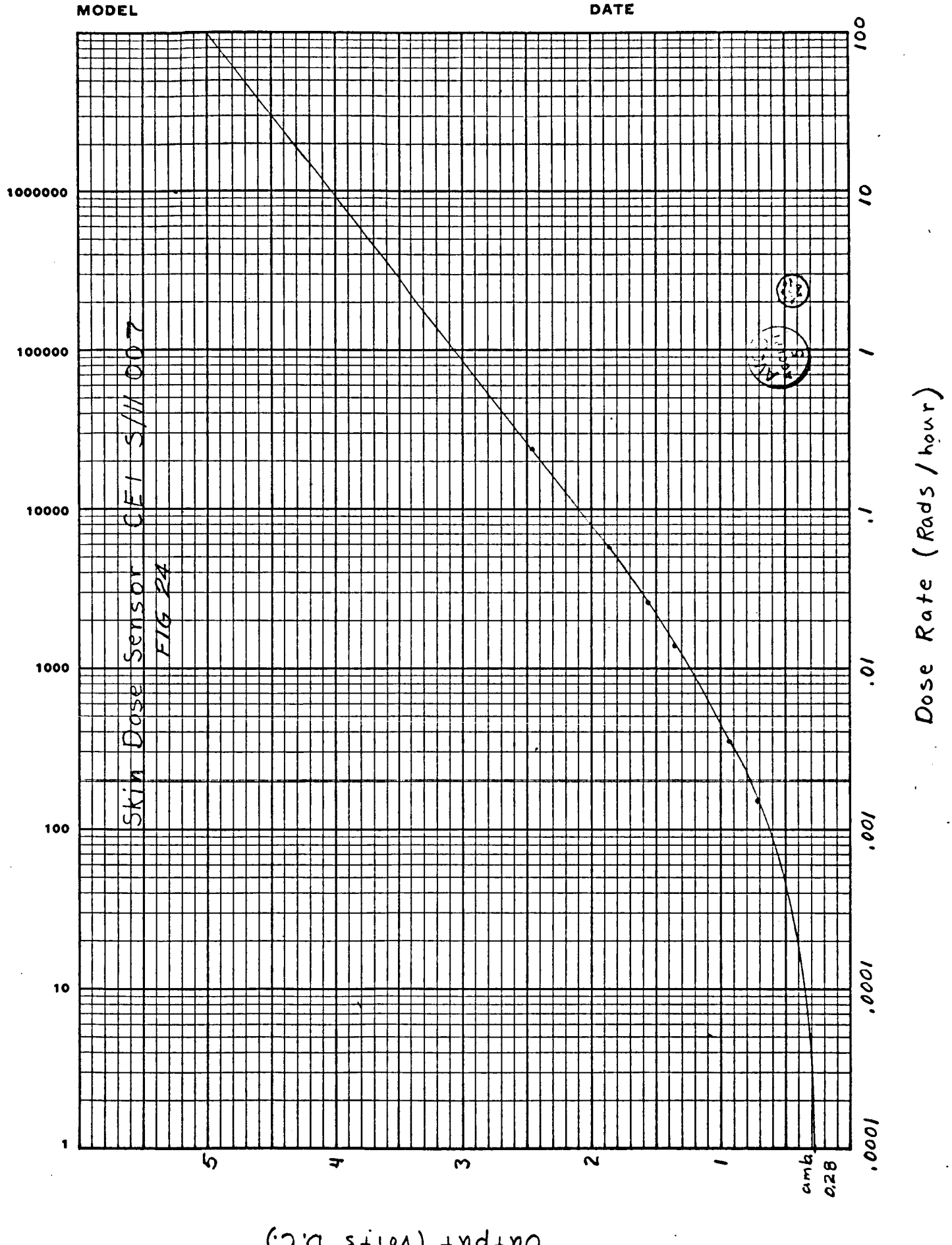



MODEL
DATE
SKIN DOSE SENSOR GAI SIN 007
FIG 20
1000000
100000
10000
1000
100
10
1
5
4
3
2
1
amb.
0.25
100
10
1
.1
.01
.001
.0001
.00001
Output (Volts D.C.)
Dose Rate (Rads/hour)
KE
7 CYCLES X 60 DIVISIONS
KEUFFEL & ESSER CO.


Dose Rate (Rads/hour)
Output (Volts D.C.)
Depth Dose Curve for FIG 27
KEUFFEL & ESSER CO. MADE IN U.S.A.
3 CYCLES X 70 DIVISIONS
sens.
amb.
min.


MODEL
DATE
Depth Dose Sensor GE1 S/N 008
FIG 22
Output (Volts D.C.)
Dose Rate (Rads/hour)
1000000
100000
10000
1000
100
10
1
100
10
1
.1
.01
.001
.0001
.0001
5
4
3
2
1
amb.
0.24
K+E SEMI-LOGARITHMIC
7 CYCLES X 60 DIVISIONS
KEUFFEL & ESSER CO.
46 6463
MADE IN U.S.A.


Skin dose sensor CEI SAV 07
Fig 23
Output (Volts D.C.)
Dose Rate (Rads / hour)
100
10
1
.1
.01
.001
sens.
min.
5
4
3
2
1
3mb.
0.28
KEUFFEL & ESSER CO.
5 CYCLES X 70 DIVISIONS
MADE IN U.S.A.


MODEL
DATE
1000000
100000
10000
1000
100
10
1
100
10
1
.1
.01
.001
.0001
.0001
5
4
3
2
1
amb
0.28
Skin Dose Sensor GE1 S/N 007
FIG 24
Dose Rate (Rads / hour)
Output (Volts D.C.)
SEMI-LOGARITHMIC
7 CYCLES X 60 DIVISIONS
KEUFFEL & ESSER CO.
MADE IN U.S.A.
46 6463